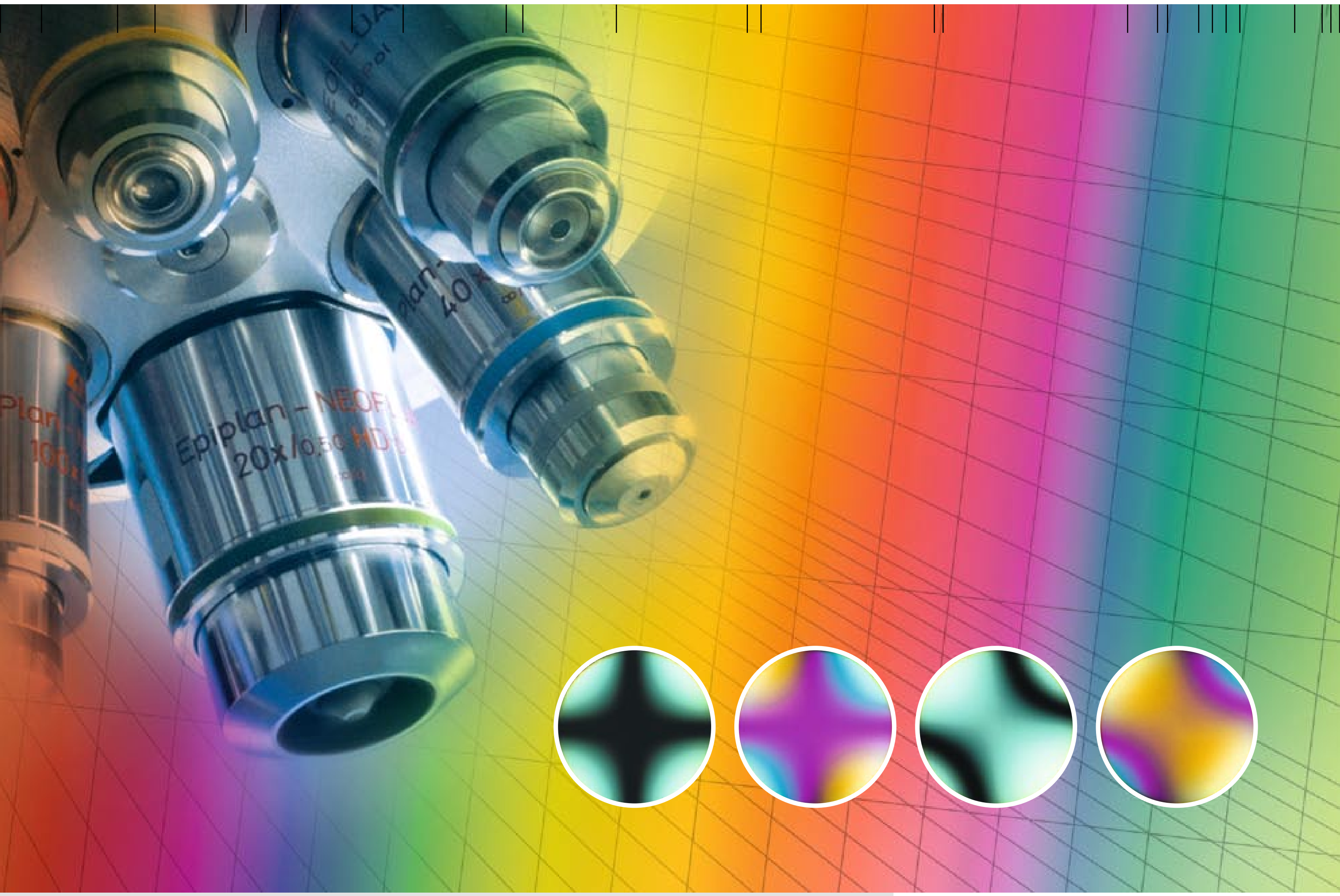
Michel-Lévy Color Chart

Identification of minerals in polarized light



Information on Polarization Microscopy

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Polarization in transmitted light

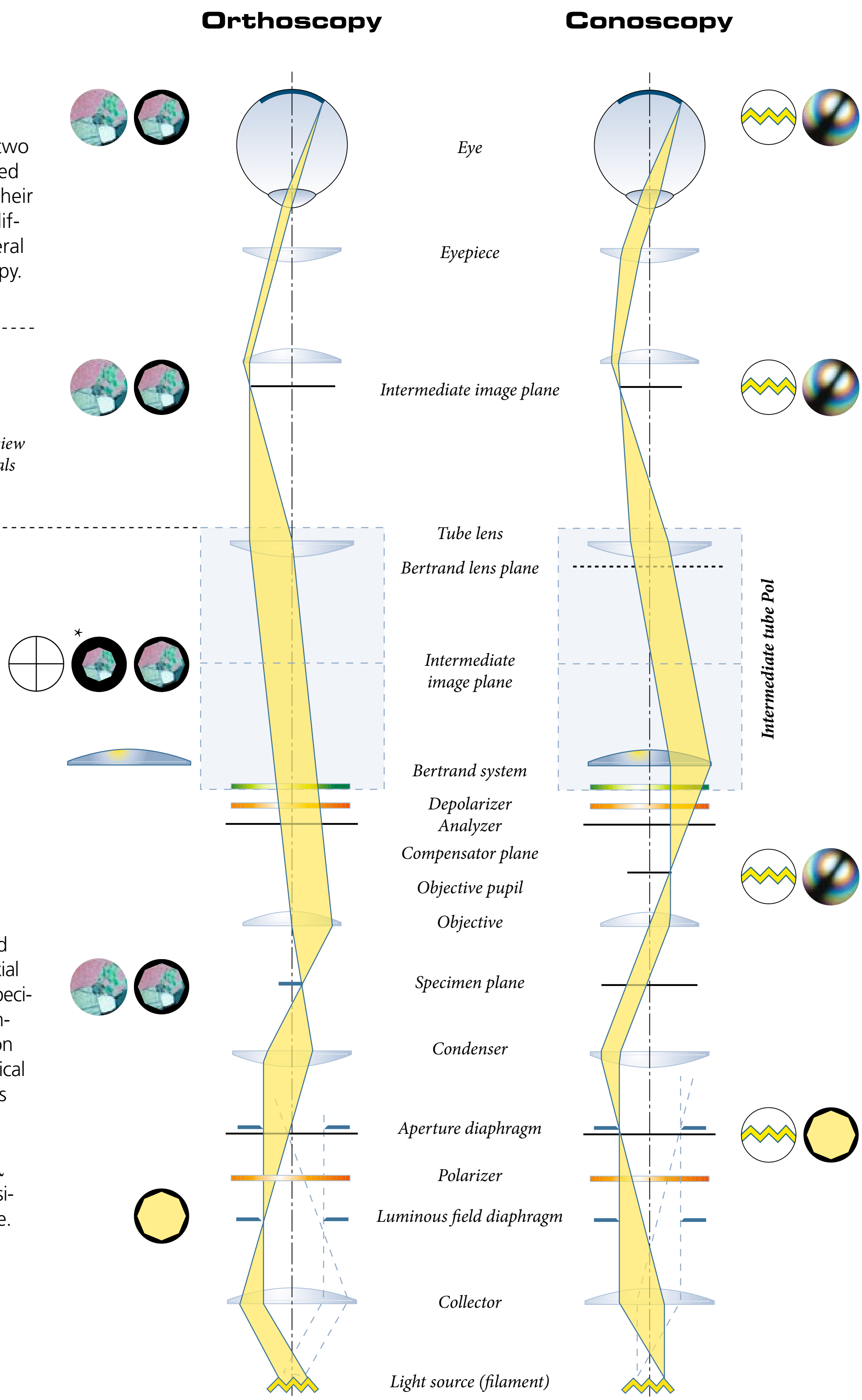
Orthoscopy and conoscopy are the two key methods in traditional transmitted light polarization microscopy. With their different approaches, they provide different options, for example for mineral identification in geological microscopy.

The Phototube Pol is designed for high-performance conoscopy.

Thanks to its additional intermediate image plane with suspended crosshair and field of view diaphragm, it permits the conoscopy of crystals larger than 10 µm.

In orthoscopy, every object point corresponds to a point in the image. Minerals are identified by morphological and optical properties like shape, cracks, color and pleochroism, and by their characteristic interference colors. In conoscopy on the other hand, every image point corresponds to a direction in the specimen. This technique requires the use of the highest objective and condenser aperture possible.

When the Amici-Bertrand lens is placed in the light path, the interference or axial image in the back focal plane of the specimen becomes visible. Conoscopy is employed whenever additional information about the specimen is required for optical analysis. It provides interference images that can be seen through the eyepiece and enables differentiation according to 1 or 2 axes and with compensator λ (λ-plate, Red I), according to 1-axis positive/negative or 2-axis positive/negative.



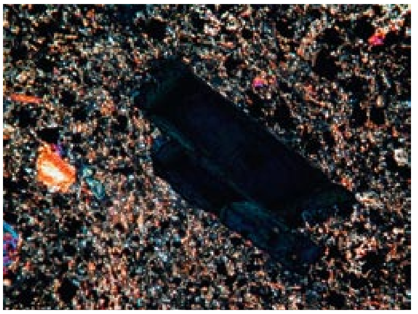
** Field of view diaphragm*

Determination of birefringence by means of the Michel-Lévy Color Chart

When a ray of light enters an anisotropic medium, it is almost always split into two linearly polarized waves; the ordinary and the extraordinary ray. Both partial rays are characterized by different propagation rates due to different refraction indices. This characteristic is called birefringence. The oscillation planes of these two partial rays are perpendicular to each other.

The superposition of the two partial waves (constructive or destructive) is called interference; the colors which appear under crossed (90°) polarizers are called interference colors.

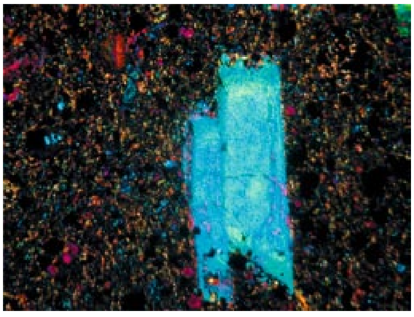
1



Rotating the mineral into the position of extinction

- Total extinction (darkest position of mineral)

2



Rotating the mineral into a diagonal position

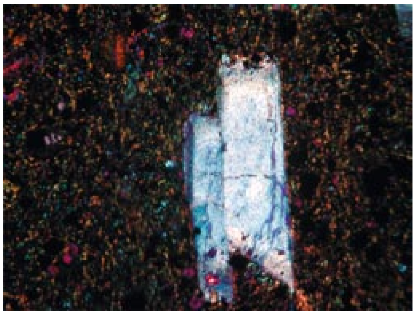
(45° from position of extinction)

- Maximum brightness
- Identification of interference color: blue

This amounts to two distinct possibilities:

- second order blue (path difference ca 655 nm)
- third order blue (path difference ca 1150 nm)

3

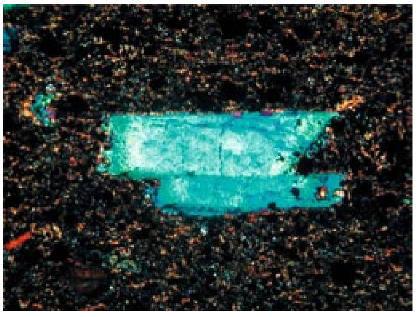


Inserting the lambda compensator

(Addition of a path difference of 551 nm)
Assumption: second order blue
(path difference ca 655 nm)

Effect: In subtraction position the mineral appears lavender- to bluegrey (655 nm – 551 nm = 104 nm)

4



Rotating the mineral by a further 90°

Effect: In this position (addition position) the mineral appears greenish blue (655 nm + 551 nm = 1206 nm)

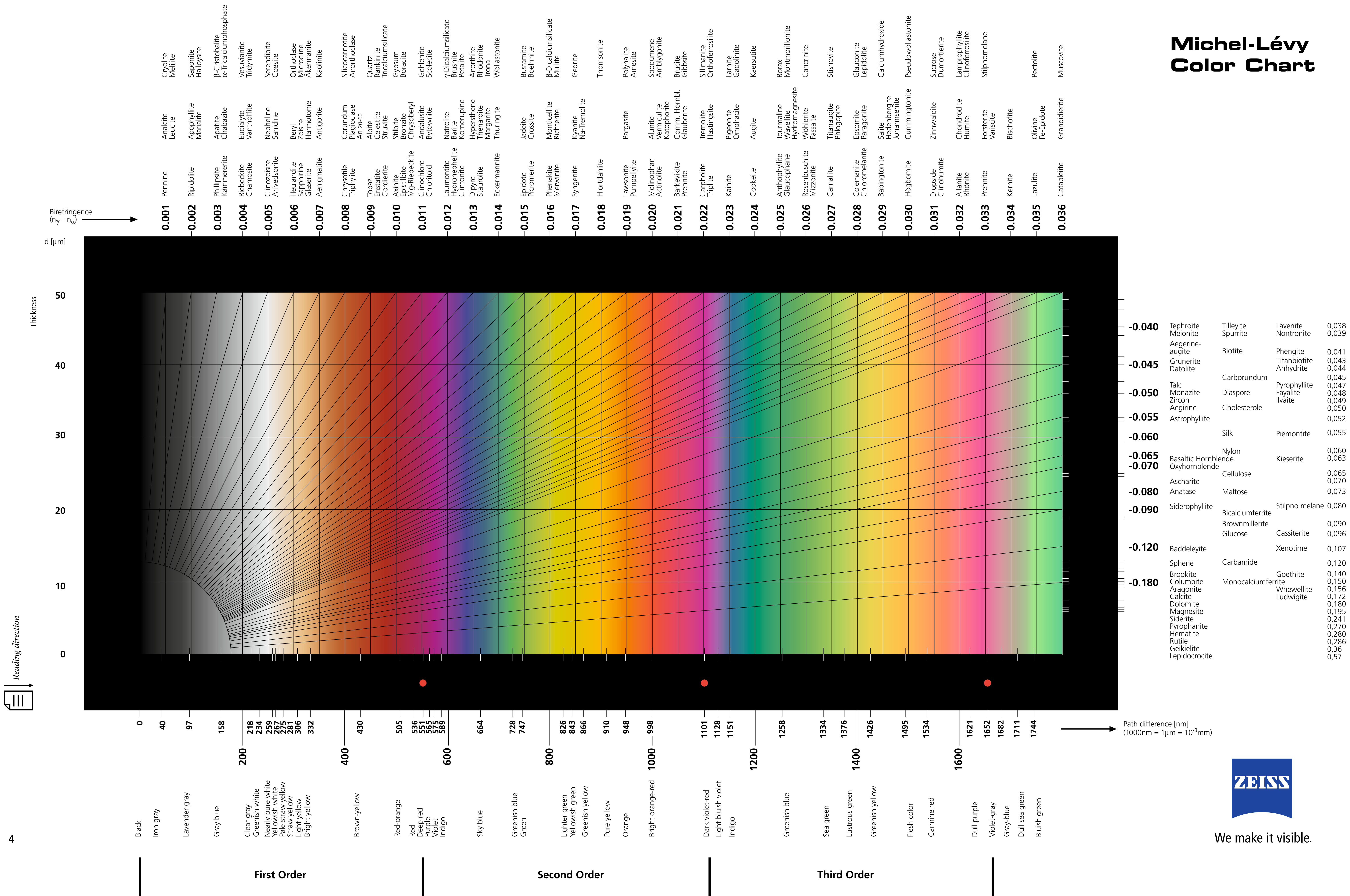
Result: The interference color has been identified as a second order blue.

5

Determining the birefringence with the Michel-Lévy Color Chart

Follow the 655 nm line of the path difference across to find the intersection with the corresponding thickness line (usually 25 – 30 µm). From this intersection, follow the "sun line" downwards towards the bottom right to pinpoint the respective birefringence magnitude on the scale on the right. In this case this leads to a birefringence value of 0.024; the mineral has been identified as an **augite**.

Michel-Lévy Color Chart



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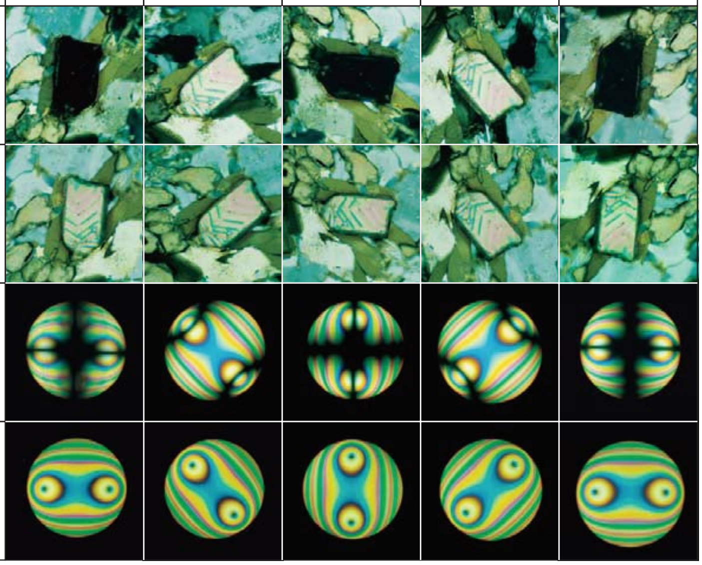
Linearly and circularly polarized light

State of polarization of the light			Rotation of the microscope stage				
			0°	45°	90°	135°	180°
Specimen	Zircon	linear					
		circular					
	Muscovite	linear					
		circular					

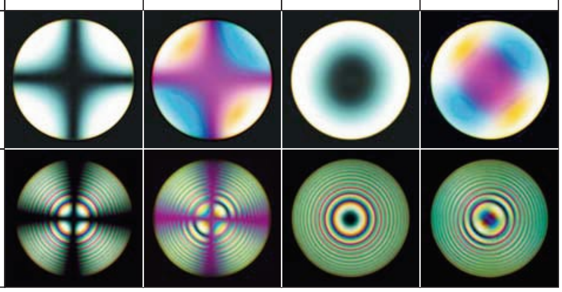


In contrast to linear polarization, circularly polarized light allows minerals to display their interference colors devoid of extinction. For that reason, circular polarization is the preferred method for image analytical procedures.

Behavior of optically anisotropic crystals in linearly and circularly polarized light, orthoscopy and conoscopy.

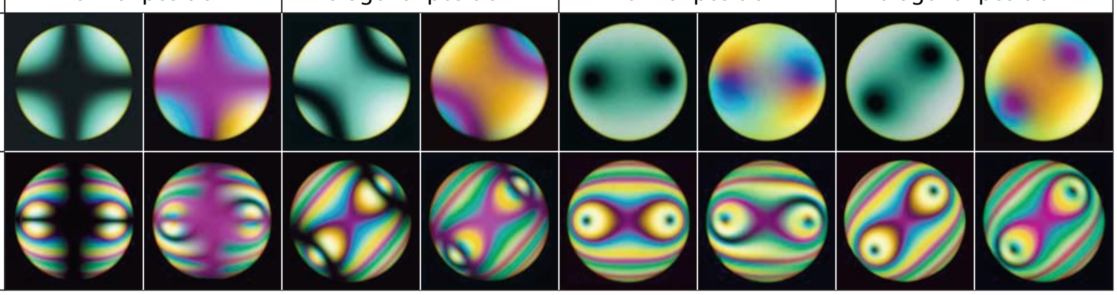
Determination of the optical character

uniaxial	State of polarization of the light			
	linear		circular	
	compensator λ			
	without	with	without	with
positive quartz				
negative calcite				



Determination of the optical character of uniaxial and biaxial minerals in linearly and circularly polarized light. The reference direction ny of the λ-compensator is aligned in NE-SW.

biaxial	State of polarization of the light							
	linear				circular			
	compensator λ							
	without	with	without	with	without	with	without	with
	normal position		diagonal position		normal position		diagonal position	
positive barite								
negative muskovite								



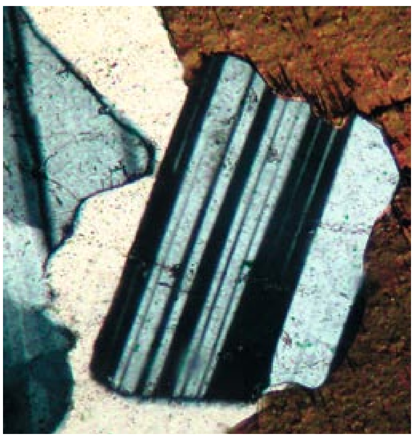
Highlights of minerals analysis

Auguste Michel-Lévy (1844 – 1911)
French geologist, Inspector General of Mining and director of the Geological Survey in France, made a name for himself by his research into extrusive rocks, their microscopic structure and origin.

Until this day, the interference color chart proposed by him in 1888 remains an important tool in the identification of thin sections of minerals with polarization microscopy.

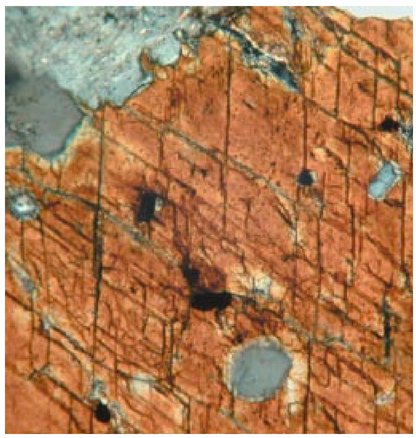
Then as now, Carl Zeiss sets benchmarks with their polarized light microscopes, in mineralogy and petrography as well as materialography and other application fields.

Mineralogical microscope stand of 1906.



Plagioclase (feldspar)
Twin lamination

Pyroxene
Cleavage angle ca. 87°



Amphibole
Cleavage angle ca. 124°

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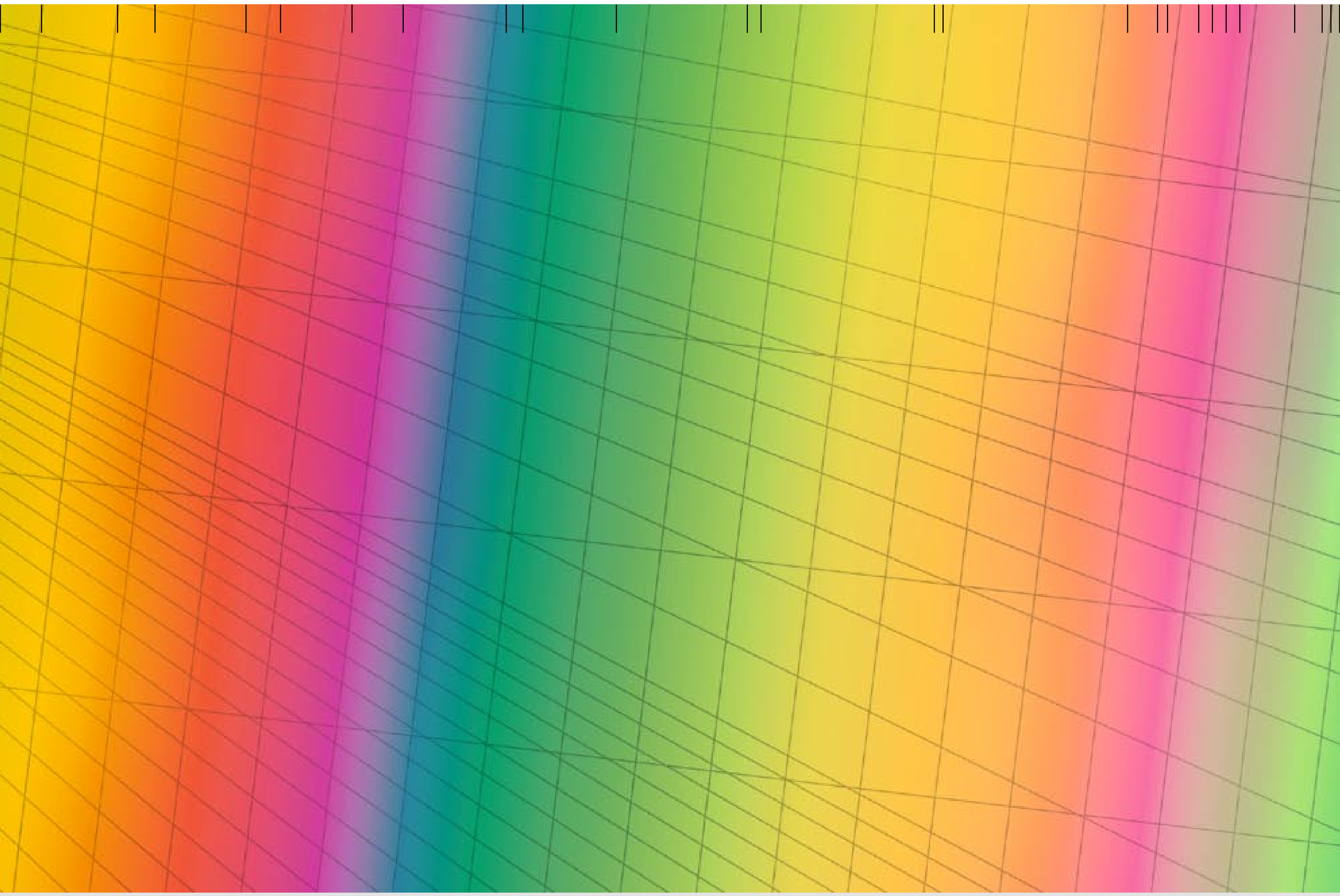

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